Preliminary Assessment of Greenhouse Gas Emissions Associated with Activities in Bloomington, Indiana: Inventory and Trends

A Report by the City of Bloomington Environmental Commission
Bloomington, Indiana, July 2006

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Executive Summary

In order for the City of Bloomington to fulfill its commitments, as signatory to the Mayors Climate Protection Agreement and City Council Resolution 06-05, to reduce climate change by reducing greenhouse gas emissions, those emissions must first be quantified. Anthropogenic greenhouse gas emissions include gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide that are produced from combustion of fossil fuels and other human activities. The purpose of this report is to establish a baseline of Bloomington's major greenhouse gas emissions, identify those sectors where the largest reductions could be achieved, and assist in setting realistic goals for emissions reductions.

It is hard to imagine any human activity that does not contribute in some way to the release of greenhouse gases. Whether directly through combustion of fossil fuels in our cars or indirectly from the production and transportation of the products we use every day, almost everything we do has an impact. Accounting for the aggregate emissions generated in our daily lives would be nearly an impossible task. Even in cities such as Seattle, where large amounts of resources have been dedicated to addressing climate change, there has been no methodology developed that could capture the emissions associated with all of the imported goods coming into a community[1]. As such, the scope of this inventory is limited to the major source categories of transportation, heating and electric energy consumption, and solid waste. This level of scope is consistent with inventories of other cities that have joined the US Mayors Climate Protection Agreement. Each section of this report describes the accounting procedure and calculations, and the sources of uncertainty associated with the calculations. Calculations were performed for the most recent year for which complete sets of data are available (2004), and for a baseline year by which to set a reduction goal (1990). The basic procedure for the calculations took raw data about activity in the major source categories, mainly from the Bloomington Environmental Quality Indicator (BEQI) report, and multiplied that by a carbon emission factor for that activity. The carbon emission factors used in this case were those published by the Intergovernmental Panel on Climate Change (IPCC)[2]. The IPCC was established by the World Meteorological Organization and the United Nations Environment Program "to facilitate understanding of the risk of human induced climate change, its potential impacts and options for adaptation"[3]. Emission factors published by IPCC are the same ones used by countries that have joined the international Kyoto Protocol and are considered to be accurate. In most cases for this report, a few additional calculations were required to manipulate the raw data into the correct units for its respective emission factor.

The Kyoto Protocol calls for a 7% reduction of greenhouse gas emissions by 2012. Many of the other cities that have joined the US Mayors Climate Protection Agreement also use this timeframe as their target goal. This report was written with that goal in mind; however Bloomington is entering the game at a disadvantage with only six years to achieve this goal. Figures in each category demonstrate the potential difficulty of reaching the goal. The Mayors Agreement does not dictate a timeline, and a realistic goal for Bloomington should be set along with a finalized action plan for greenhouse gas reductions. The magnitude of the goal is quite large. In order to reach the goal of the Kyoto Protocol, Bloomington will need to reduce its annual greenhouse gas emissions by 246,535 tons of carbon dioxide equivalents from 2004 levels, not counting the increases that will occur due to population growth. Figures 1 and 2 illustrate the relative proportions of CO_2 emissions from the major source categories estimated in this report. These figures should help determine where the largest reductions could be achieved at the least cost.

Figure 1. 2004 emissions (metric tons CO_2).

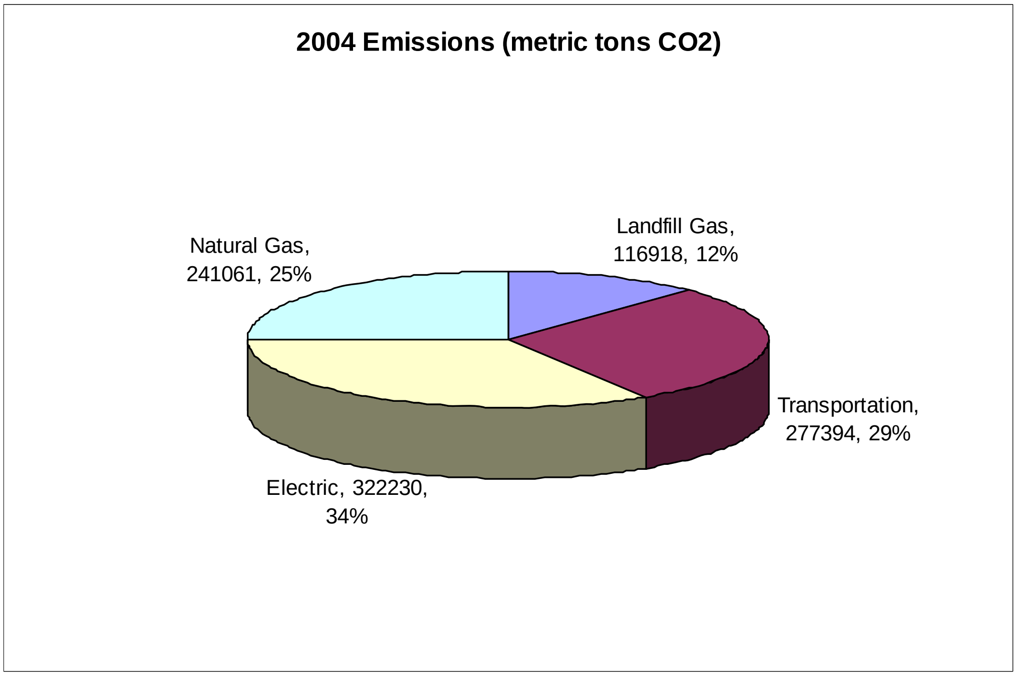
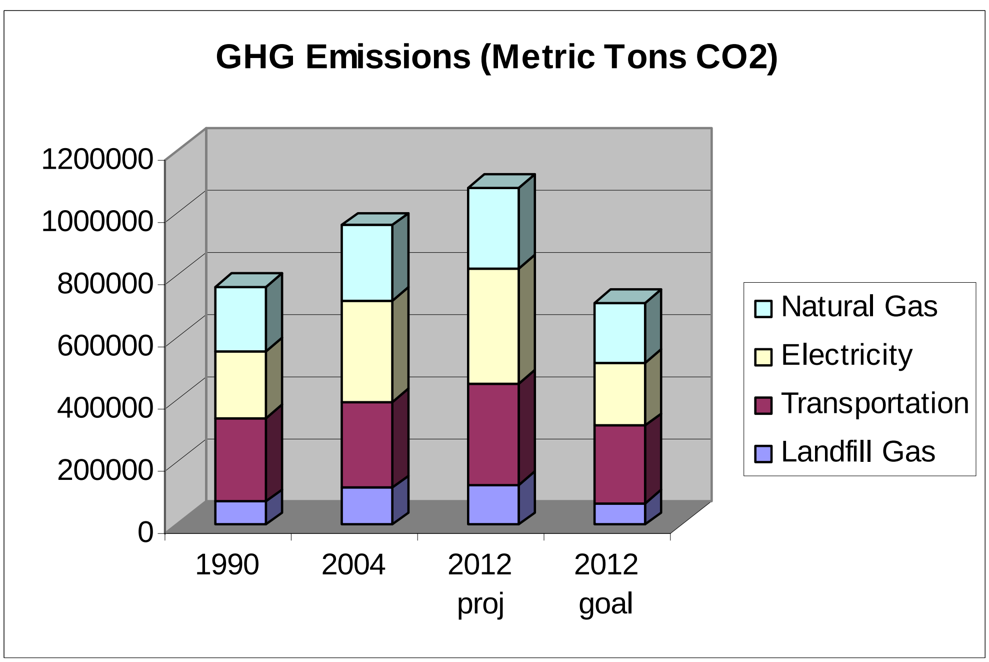


Figure 2. Bloomington Greenhouse Gas emissions (metric tons CO_2).



It is important to note that the quantities of greenhouse gas emissions reported here are estimates. It is not possible for this or any other city to measure greenhouse gas emissions with total accuracy given the number of sources. However, many other cities are able to make more accurate estimations due to the greater availability of data. This report would not have been possible if the Bloomington Environmental Commission had not already been tracking some of the data included here. Some of the data limitations faced here are out of the hands of Bloomington officials. For example information about the age and type of vehicles driven by everyone in Bloomington is not tracked by the State or otherwise available to more accurately assess greenhouse gas emissions from these vehicles. The City of Bloomington will need to work with the State and our energy providers to maintain a level of data availability for this initiative to be successful. At this point the availability of crucial data on utility usage is limited, and it appears that it will be less available in the future.

Estimation of Greenhouse Gas Emissions from Activities in Bloomington

Electricity

Electricity for the Bloomington area is primarily generated at facilities outside of Monroe county, which combust either coal or natural gas as a fuel source. Currently, approximately 95% of the electricity that is used in Bloomington is derived from coal and 5% from natural gas, with renewable sources making up a negligible fraction[4]. Total usage for Bloomington for both the 2004 and 1990 were obtained from the Bloomington Environmental Quality Indicator report[5]. Equation 1 demonstrates how emissions were calculated in this category.

Equation 1:

$$\text{Carbon Emissions} = (\text{Mwh}*(\%\text{ from fuel source})*(EF_{\text{fuel source}}))$$

Where Mwh is megawatt hours (1,000,000 watts of power used for one hour), % from fuel source refers to the percentage of electricity generated by a given fuel source either coal or natural gas, and $EF_{\text{fuel source}}$ is the IPCC emissions factor for that fuel source.

For example, in 2004, usage in Mwh for the three primary sectors: residential, commercial, and industrial, was:

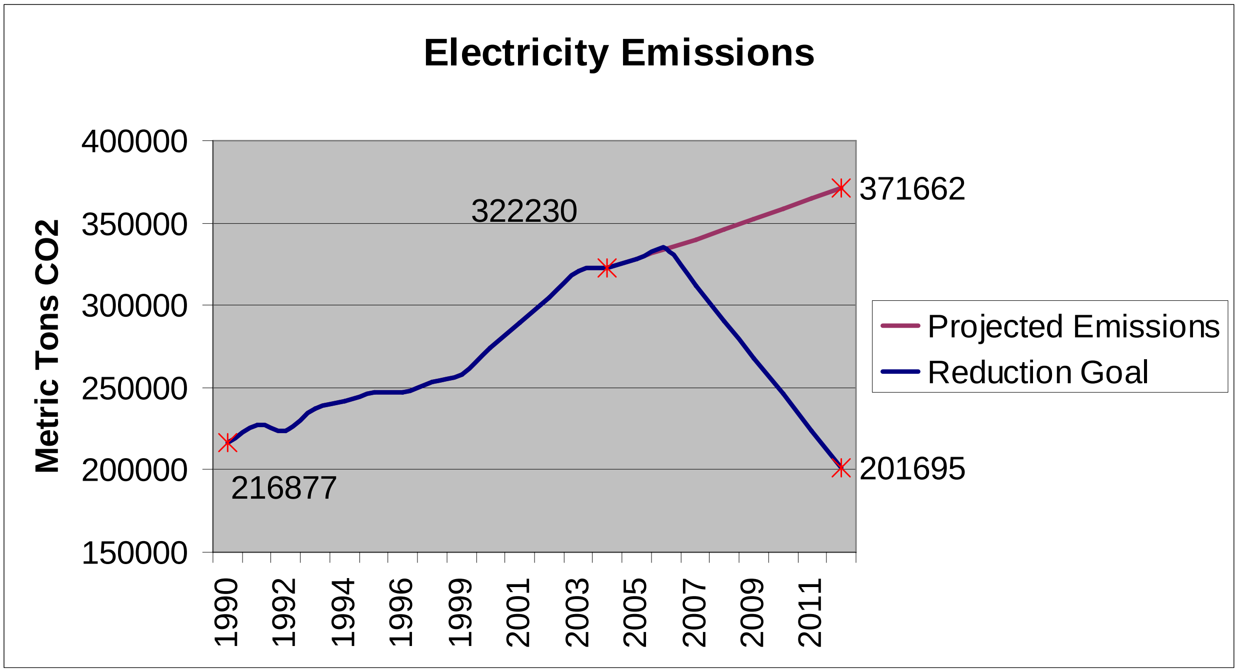
Residential: 349,439
Commercial: 468,818
Industrial: 153,602

Given that the percentage of electricity generated by either coal or natural gas in 2004 was 95 and 5 percent respectively, and given an emission factor of 94kg CO_2/GJ for coal and 56kg CO_2/GJ for natural gas[6], the number of metric tons of CO_2 released for the three sectors in 2004 was:

Residential: 115,860
Commercial: 155,441
Industrial: 50,928 for a total of 322,229.6 metric tons of CO2 from electricity generation.

Figure 3 shows trends in emissions from 1990 and the projected path to meeting a 7% reduction of 1990 and a "business as usual" projection based on information from the US Department of Energy[7] emissions levels for electricity generation. Calculations for 1990 were the same as above, with the percentages of coal and natural gas fuels at 98 and 2 percent respectively.

Figure 3. Bloomington Greenhouse Gas Emissions from electricity generation.



Transportation

According to the United States Energy Information Association (EIA), after 1999, transportation-related emissions overtook industrial greenhouse gas emissions to become the largest source of greenhouse gases released by human activities in the United States. Currently, growth in petroleum-related emissions is far outpacing growth from coal and natural gas-related emissions. The percentage growth in emissions in 2004 was as follows:[8]

Petroleum: 3.7%
Coal: 0.3%
Natural Gas: 0.1%

While the increase in petroleum-related emissions may seem counterintuitive based on the fact that car fuel efficiency is improving, the growth in emissions is largely due to the increase in the number of miles the average person drives each day.

Privately-owned vehicles: Calculating emissions in this category is more difficult than other categories because of the nature of private transportation. Unlike other forms of private energy consumption such as electricity and natural gas, there is no single source of the fuel consumed where aggregate usage can be measured. Additionally the varieties of different types of motor vehicles with their own emissions characteristics and control technologies make this calculation even more difficult. There are many assumptions behind the calculation of greenhouse gas emissions from this category, which inevitably introduces a degree of uncertainty. Still, given the data limitations faced, the estimation provides a good working estimate of actual emissions.

Because there is no direct measurement of the amount of fossil fuel consumed in this activity, emissions are estimated based on average driving distances. The finest scale data available on vehicle miles traveled (VMT) is at the county level, and thus the calculated emissions were adjusted by population to estimate the Bloomington portion. The emission factors obtained from the IPCC vary with the age of the vehicle to represent the emission control technology that was standard for the year in which the vehicle was produced. Table 1 shows the breakdown of the different emission control technology categories. Using the 2001 National Household Transportation Survey[9] published by the U.S. Department of Transportation, two vehicle age classes were defined for 2004 data (see Table 2). The percentage of vehicles that were older than 8 years were placed in the "early 3-way catalyst" class. Those that were younger were placed in the "3-way catalyst" class.

Again, there are many assumptions that affect these calculations. First, it is assumed that the number of vehicles still in operation that were produced before 1983 are responsible for a negligible amount of the total VMT. It is also assumed that there is no difference in the relative number of miles traveled between newer (3-way catalyst) models and older (early 3-way catalyst) models, and that there is no difference in the number of miles driven by different types of vehicles (cars, light trucks, and heavy trucks). Although gathered between 2001 and 2002, the data from the National Household Transportation Survey regarding the vehicle age distribution are likely to be similar to the age distribution in 2004. The National Household Transportation survey also included percentages for 1990, and these were used for the calculations for that year.

Table 1.

Emission Control Technology Types and US Vehicle Model Years Used to Represent Them	
Technology	**Model Year**
Gasoline Passenger Cars and Light Trucks	
Uncontrolled	1964
Non-catalyst controls	1973
Oxidation catalyst	1978
Early three-way catalyst	1983
Three-way catalyst	1996
Heavy-Duty Gasoline Vehicles	
Uncontrolled	1968
Non-catalyst control	1983
Three-way catalyst	1996
Diesel Passenger Cars and Light Trucks	
Uncontrolled	1978
Moderate control	1983
Advanced control	1996
Heavy-Duty Diesel Vehicles	
Uncontrolled	1968
Moderate control	1983
Advanced control	1996
Motorcycles	
Uncontrolled	1973
Non-catalyst controls	1996

(Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual)

Table 2.

Distribution of Vehicles by Vehicle Age and Vehicle Type
1977, 1983, 1990, 1995 NPTS, and 2001 NHTS
(percentage)

Vehicle Age	1977			1983			1990			1995			2001		
	Auto	Truck/ Van	All	Auto	Truck/ Van	All	Auto	Truck/ Van	All	Auto	Truck/ Van	All	Auto	Truck/ Van	All
0 to 2 years	*27.3*	*29.9*	*27.8*	*20.0*	*16.6*	*19.2*	*15.6*	*19.7*	*16.6*	*14.9*	*19.2*	*16.2*	*13.27*	*18.59*	*15.41*
3 to 5 years	*30.4*	*25.6*	*29.6*	*28.0*	*26.6*	*27.6*	*27.7*	*27.2*	*27.5*	*21.7*	*21.6*	*21.5*	*20.37*	*23.47*	*21.51*
6 to 9 years	*26.7*	*21.1*	*25.7*	*27.4*	*25.0*	*26.9*	*26.8*	*20.9*	*25.3*	*30.3*	*25.5*	*28.5*	*25.45*	*22.59*	*24.08*
10 or more years	*15.6*	*23.4*	*16.9*	*24.6*	*31.8*	*26.3*	*29.9*	*32.2*	*30.6*	*33.1*	*33.7*	*33.8*	*40.91*	*35.36*	*39.00*
Total	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***
Average Age	5.5	6.4	5.6	6.7	7.8	6.9	7.6	8.0	7.7	8.2	8.3	8.3	9.0	8.5	8.9

(2001, National Household Transportation Survey)

In 2004, the percentage breakdown by vehicle type was estimated as 73.1% cars, 24.2% light trucks, and 1.4% heavy trucks by the Indiana Bureau of Motor Vehicles[10]. These percentages are used to represent the share of VMT that each type of vehicle is responsible for. Equation 2 demonstrates the calculation procedure for private transportation emissions.

Equation 2:

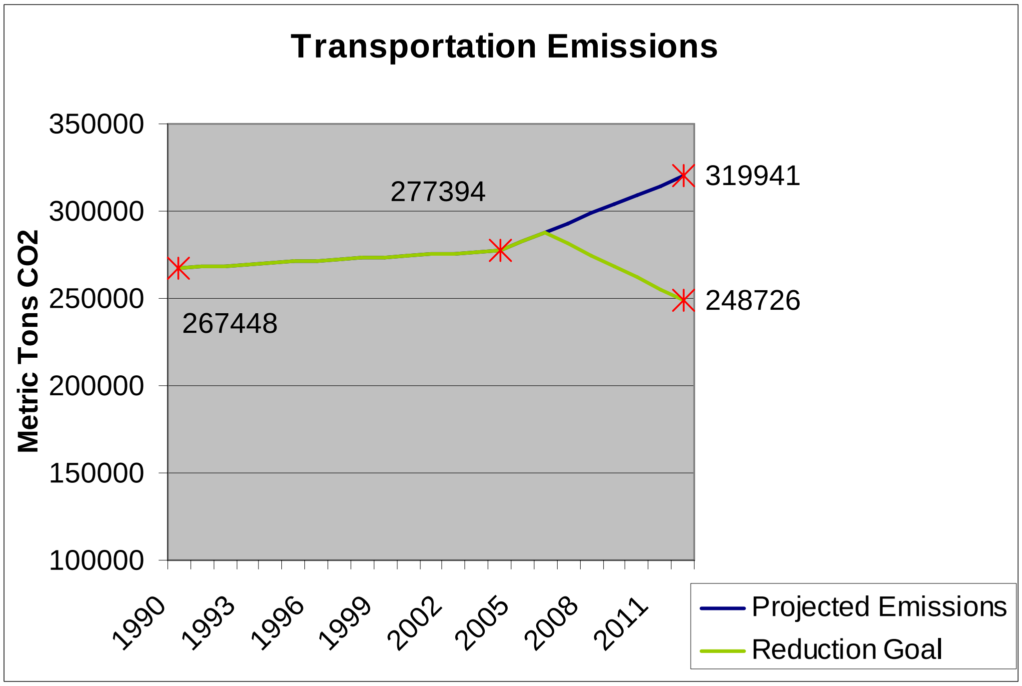
Carbon Emissions = (VkmT)*(Vehicle Type%)*(Age Class%)*$EF_{(\text{Vehicle Type, Age class})}$)

Where VkmT refers to vehicle kilometers traveled, Vehicle Type% refers to the percentage of cars, light trucks and heavy trucks, Age Class% refers to the percentage of a given vehicle type in the two age classes, and $EF_{\text{Vehicle Type, Age class}}$ refers to the IPCC emissions factor for the given vehicle type and age class.

For example, for cars, total vehicle miles traveled (VMT) was converted to kilometers (VkmT), multiplied by the percentage of cars, multiplied by the percentage of cars older than 8 years, multiplied by the emission factor for an *early* 3-way catalyst for CO_2. This was added to a similar calculation using the percentage of cars younger than 8 years and the 3-way catalyst emission factor. An identical procedure was then carried out for methane emissions and methane emissions were converted to carbon equivalents. This procedure was the same for light and heavy trucks, except that the emissions factors used for the heavy truck category are for diesel fuel rather than gasoline.

Final emissions were then adjusted by population to find the amount that resulted from Bloomington residents. This is based on a clearly oversimplified assumption that the average city resident drives the same amount as the average county resident. Also certainly a number of county residents do much of their driving in the city. However there is no way of quantifying those among other factors, so adjusting for population is the best way to estimate at this time. In 2004 the total greenhouse gas emissions from transportation activities in Bloomington was 277,394.08 metric tons of carbon equivalents. Figure 4 shows trends in emissions from 1990 and the projected path to meeting a 7% reduction of 1990 emissions levels for this category.

Figure 4. Bloomington Greenhouse Gas Emissions from transportation.



City fleet: A more precise inventory for the city operations is possible since there is a record of the amount of fuel used. In this case, emissions are calculated by simply multiplying the amount of fuel by its emissions factor of 3,172.31 gCO_2/kg fuel[11]. For example in the year 2004, fuel purchases by the Public Works Department resulted in emissions as follows:

Gasoline: 170,797 gallons 1,495.42 metric tons of CO_2 released
Diesel Fuel: 119,795 gallons 1,223.68 metric tons of CO_2 released

Converting gallons to kilograms of fuel and multiplying these fuel volumes by the IPCC emissions factors for gasoline and diesel fuel yields a total of 2,719.11 metric tons of CO_2 produced from the operation of city owned vehicles in 2004. Reductions from City of Bloomington owned vehicles can be easily documented when policies to reduce usage are in place.

Some actions taken by the city are already helping to reduce our greenhouse gas emissions. In 2004, Bloomington Transit began purchasing B20 bio-diesel which is a blend of 20% bio-diesel and 80% regular diesel for some of its operations, switching completely to B20 bio-diesel in 2005. The amount of CO_2 released from the combustion of bio-diesel is essentially the same as from regular diesel fuel. However it is estimated that 73% of the carbon content in bio-diesel is from soybean biomass. The carbon in those soybeans was taken from the atmosphere within the past year and thus releasing it is considered to be emission neutral. Unlike use of fossil fuels, the release of CO_2 from the combustion of the biofuel portion of the blend is considered as producing no net addition of carbon to the atmosphere as CO_2.

While the burning of biofuels is considered emission neutral, it should be noted that fossil fuel use and the subsequent emissions associated with the production of biofuels may negate that benefit[12]. Furthermore new developments in removing high cellulose crop residue from the field for ethanol production may be more environmentally damaging in terms of increased erosion of topsoil, leading to increased dependence on fossil fuel based fertilizers.[13] However these drawbacks depend largely on the details of how the biofuel crop was grown and how it was processed. Untangling this complex issue will require a life cycle greenhouse gas accounting procedure for the biofuel industry, which is currently lacking[14]. In the meantime we will treat biofuels as if the emissions associated with its production are commensurate with that of regular fossil fuels and we will only account for those emissions which occur in the Bloomington area.

In 2004, Bloomington Transit purchased 236,236 gallons of regular diesel, and 12,796 gallons of a 20% bio-diesel blend. Had regular diesel only been used, 2543.82 tons of CO_2 would have been released. Subtracting the amount of biomass derived carbon, i.e. 73% of the bio-diesel blend, leaves a total of only 2524.73 tons, a difference of 19.09 tons. Based on 250,000 gallons as an approximation of the amount of fuel purchased per year, projected reductions in CO_2 emissions for the year 2005, when Bloomington Transit was using bio-diesel throughout the year, total over 372 tons. Once total fuel purchase data is available for 2005 an exact total can be computed easily.

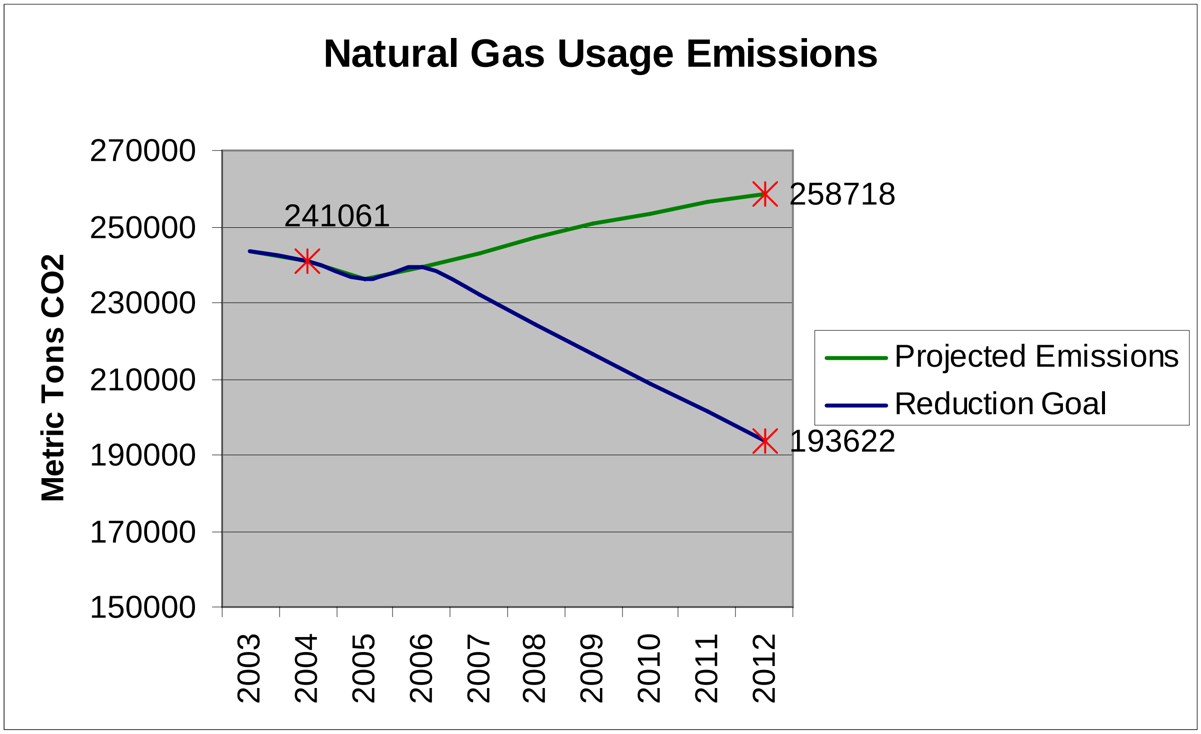
Natural Gas

While cleaner than other fossil fuels from a standpoint of particulate matter, sulfur and nitrogen oxides[15], natural gas combustion produces carbon dioxide and water as by-products. The estimation of emissions in this category was severely hampered by lack of basic data on natural gas usage in Bloomington. The only years for which data is currently available are 1996, 1997, and 1998[16]. Estimations on usage for both 1990 and current usage was calculated using percent differences of total United States consumption from 1997 to those dates. Projections beyond the year 2004 are based on consumption predictions from the Energy Information Administration in the U.S. Department of Energy[17]. Usage rates that were once provided by Indiana Gas were reported in dekatherms (Dth), which were converted to gigajoules (GJ). The number of gigajoules was then multiplied by the IPCC emission factor of 56000g CO_2/GJ as demonstrated in Equation 3. Figure 5 shows trends in emissions from 1990 and the projected path to meeting a 7% reduction of 1990 emissions levels for this category.

Equation 3.

$$\text{Carbon Emissions g} = (\text{Dekatherms} * 1.055\ \text{GJ/Dth}) * 56000\text{g}CO_2/\text{GJ}$$

Figure 5. Bloomington Greenhouse Gas Emissions from natural gas use.



As can be seen in Figure 1, carbon dioxide emissions from natural gas represent a substantial contribution (25%) of the total for Bloomington. Usage statistics that were provided by Indiana Gas when they were the natural gas provider from Bloomington made this calculation possible. Establishing a similar relationship with the current provider, Vectren Corporation, will be necessary for a greenhouse gas reduction plan to be implemented. Usage rates from the time that Vectren became the natural gas provider will be needed to find what actual usage has been, and continual updates to track emissions reductions will be needed to allow Bloomington's greenhouse gas reduction efforts to encompass this major source category.

Solid Waste

Greenhouse gas emissions from solid waste are caused by the breakdown of organic material within the waste stream. There are two processes by which this organic material is degraded, aerobic and anaerobic. The difference is whether the degradation occurs in the presence of oxygen (aerobic) or not (anaerobic). During aerobic degradation, bacteria take in oxygen, consume organic material, and respire carbon dioxide in the same way that humans do. Under anaerobic conditions such as those deep within a landfill, different types of bacteria thrive. These other types of bacteria, collectively known as the "methanogens," use a different metabolic pathway to derive energy from food which results in respiration of both carbon dioxide and methane[18]. All organic material will eventually degrade. Dead plant material such as food scraps and paper will break down by one means or another releasing its carbon back into the atmosphere.

As with the biomass-derived carbon in biodiesel, CO_2 generated in food scraps and paper products can also be considered to be carbon neutral since the items that make up the degradable portion of the waste stream had recently taken that carbon from the atmosphere[19]. Thus, our greenhouse gas emissions for solid waste will not include CO_2 emissions. On the other hand, methane generation is a result of modern landfilling practices where layers of garbage become deprived of oxygen when buried by the next layer. Thus methane produced by landfills is typically considered in greenhouse gas emissions calculations as a human- caused source of greenhouse gas, and steps can be taken to reduce it[20].

Municipal solid waste composition can vary widely depending on a number of factors including change in seasons, relative amounts of commercial versus residential waste, and rates of participation in recycling programs. The composition data used for methane generation from Bloomington is from the national average published by the EPA in 2003. Accurate data of the composition of the solid waste stream is crucial in producing a reliable estimation of methane production. Obtaining specific figures from Bloomington's solid waste stream will necessitate at least one year of sampling and should include all the waste handling providers that service businesses, apartment complexes, and residential housing in Bloomington.

Degradable organic material in municipal solid waste comes from paper, food waste, yard waste, wood, and textiles. In 2003 the average percentage of the waste stream from these categories was 35.2% paper, 11.7% food scraps, 12.1% yard trimmings and 5.8% wood[21]. Textiles will be omitted because EPA has them grouped with nondegradable products like rubber. To illustrate the need for a more accurate data, we note that Bloomington probably does not send as much yard waste as the national average thanks to the Sanitation Department's separate yard waste collection. However with no data to quantify that, the EPA data is the only estimation available. Not all of the mass of organic materials from the aforementioned categories will be degraded in the landfill. Each of the types of organic waste has a percent degradable organic carbon (DOC) associated with it, as illustrated in Table 3.

Table 3.

DEFAULT DOC VALUES FOR MAJOR WASTE STREAMS

Waste Stream	Per cent DOC (by weight)
A. Paper and textiles	40
B. Garden and park waste and other (non-food) organic putrescibles	17
C. Food waste	15
D. Wood and straw waste[1]	30

[1] excluding lignin C

Source: Bingemer and Crutzen, 1987.

(Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual)

An overall percent DOC for the waste stream leaving Bloomington can be calculated using Equation 4.

Equation 4

Percent DOC =

(.4)*(% paper) + (.17)*(% yard waste) + (.15)*(% food waste) + (.3)*(% wood)

Applying the average percentages of paper, yard waste, food waste and wood from the 2003 EPA data yields a degradable organic carbon (DOC) fraction of 0.196 of the total waste stream. This fraction along with total municipal solid waste (MSW) generated can be used to estimate the amount of methane generated using Equation 5.

Equation 5

Methane emissions(tons) =

$MSW(tons)*DOC*DOC_F*F*(16/12)$

Where

MSW = total municipal solid waste for Bloomington in (year)[22] ,

DOC = percent Degradable Organic Carbon calculated from Equation 4

DOC_F, = the dissimilated fraction of the organic carbon, default value is 0.77. This is the percentage of the available carbon that is converted into landfill gas (the remainder goes into microbial biomass or other byproducts)

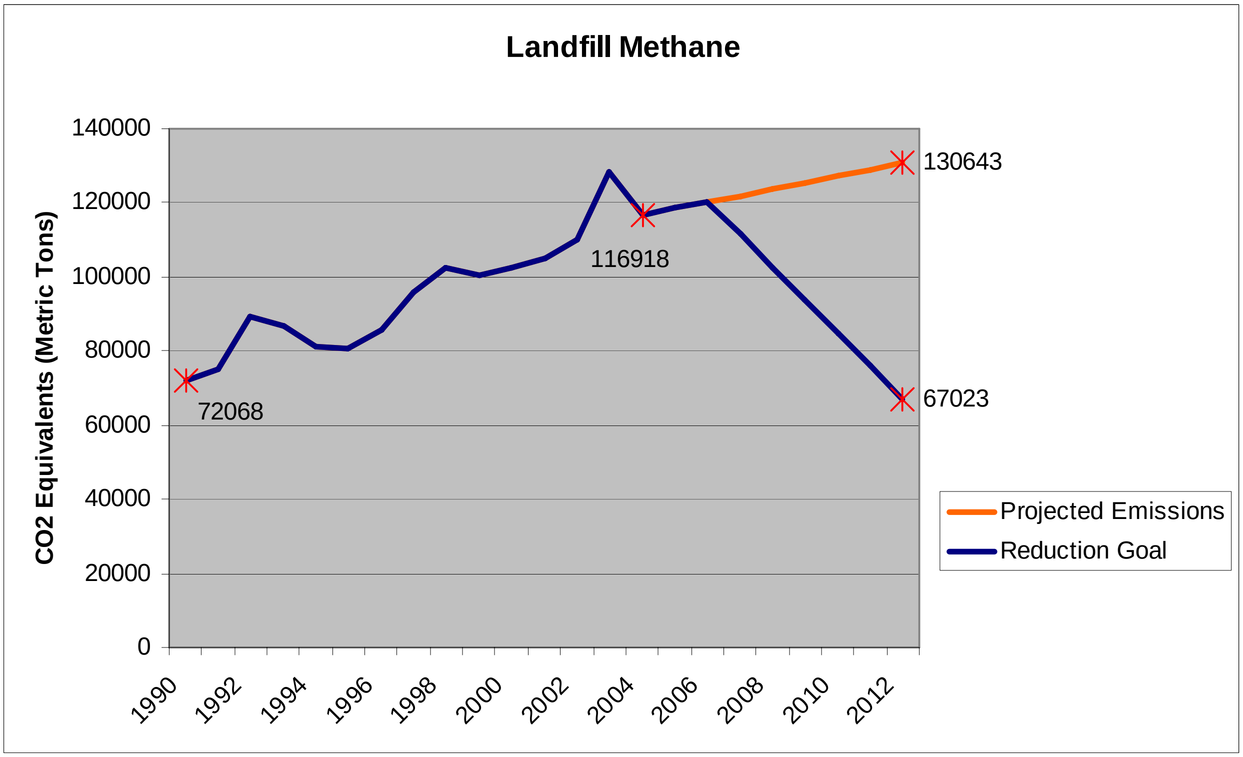
F = is the fraction of landfill gas that is methane, and has a default value of 0.5 (the remainder being mostly CO_2 with small amounts of other gases)

16/12 = a weight conversion of carbon (molecular weight 12 g/mole) to methane (molecular weight 16 g/mole).

Equation 5 has been simplified from the version that appears in the IPCC guidelines. Variables that were omitted were ones that would not change the end result of the calculation, such as a factor that accounts for the management of the landfill, which would equal 1 in industrialized countries that use landfill liner systems that exclude oxygen. Other values smaller than 1 are applied to unmanaged waste piles where there is a greater amount of aerobic degradation occurring. Another is a factor that is recognized by the IPCC as being relevant but which has not been quantified, that accounts for the portion of methane that is oxidized in the upper layers of the landfill before it escapes to the atmosphere.

In 2004, Monroe County generated 156,988 tons of landfilled garbage.[23] After going through the calculations and adjusting by population to obtain the amount of waste from Bloomington, 5,083 tons of methane are estimated to have been produced. Methane is a 23 times more potent greenhouse gas than CO_2. The calculated quantity of methane is equivalent to 116,918 tons of CO_2. It is important to note that the methane produced from one year's worth of waste will be released over several years. The calculated amount of methane produced would be representative of actual annual emissions assuming the composition of the waste stream does not vary significantly from year to year. Figure 6 shows trends in emissions from 1990 and the projected path to meeting a 7% reduction of 1990 emissions levels for this category.

Figure 6. Bloomington Greenhouse Gas Emissions from landfill methane production.



Bloomington's solid waste is currently being disposed of at the Sycamore Ridge Landfill outside of Terre Haute, approximately 60 miles away. The Sycamore Ridge Landfill is operated by Republic Services. At the beginning of this project, communications with Republic Services left a question as to whether there would be methane collection in the section of the landfill where Bloomington's waste is being disposed of. Due to these uncertainties, the solid waste category was pursued with the above results. Recent communications with Republic Services have revealed that there will be a methane collection system in this portion of the landfill, to be constructed as that section is capped[24]. This system will not only prevent the methane from escaping into the atmosphere, but will also refine the methane into a usable energy source, displacing some need for fossil fuel energy.

Reductions in the solid waste category would still be beneficial, since a reduction of waste is always more energy-efficient than production and processing of waste. By reducing the amount of organic matter entering a landfill, methane generation can be limited. Composting of yard waste could be extended to include food waste and paper products not recycled. The compost could be used on-site or near-site to nourish local gardens, thus reducing the transportation costs of taking it to the landfill[25]. Indirect emissions reductions are also possible to achieve through increased recycling participation. Certain products such as aluminum cans use 95% more energy to be produced from virgin materials than from recycled inputs[26]. Such energy use reductions can be calculated from quantities of aluminum that were recycled rather than landfilled. However, care should be taken when quantifying this type of reduction. Similar to the situation with biofuels, where there are emissions that occur outside of Bloomington, assigning those emissions to the parties responsible is difficult. Since the reductions physically occur elsewhere there may be other parties counting those same reductions. For example the facility that is manufacturing new products from recycled inputs may be counting that as a reduction for themselves. Even further down the line, an organization may be counting reductions from purchasing those recycled products. Double or even triple counting could be happening which will slow the rate at which we as a nation address climate change. This is again a question where national action is needed to appropriately address this issue. In the meantime, this is something that the City of Bloomington should be aware of as its climate protection plan takes shape.

Recommendations

(1) Involve the County

As was stated in the executive summary, the numbers reported here are estimates. All of the calculations involved in the process have some degree of uncertainty. One of the sources of uncertainty is the use of county-level data in the transportation and solid waste categories. Given the nature of these categories, it is extremely difficult to accurately separate who is responsible for what portion of the emissions. Therefore, it is recommended that the Monroe County government join in the emissions inventory effort. The county's involvement would enable a more comprehensive assessment of this community's contribution to anthropogenic climate change. Furthermore, categories that are more relevant at the county level, such as agriculture and forest land, could be included. The inclusion of forest land and certain other types of greenspace would allow the inclusion of emissions offsets. For example, because trees take CO_2 out of the atmosphere, forest land represents a CO_2 sink. The amount of CO_2 taken out of the atmosphere from net increases in forest land can be quantified and counted as an offset from Bloomington's emissions. The same principle applies to soil organic matter, which is an even larger sink for carbon than terrestrial vegetation. Practices that promote the build up of soil organic matter, such as organic agriculture and prairie restoration, could thus also be taken into account in calculating emissions offsets.

(2) Conduct a Solid Waste Audit

In the solid waste category, it is recommended that the city undertake a comprehensive waste audit. This audit should be designed to capture variation in the composition of waste leaving the city over changes in season and from the various groups that are serviced by private waste collection companies. Not only would such an audit allow for a more representative estimation of emissions in the solid waste category, it would also give an indication of real participation in recycling programs and thus of potential emission reductions from expanding the recycling program in Bloomington. Expansion of recycling programs could add up to significant reductions, if accounting methods for recycling are better standardized.

(3) Support Vehicle Emissions Testing

Characterizing private transportation accurately will always be difficult. To do so would require knowledge of the number of each type of vehicle used in Bloomington and what percentage of the vehicle miles traveled (VMT) they represent. However, if the State of Indiana were to require vehicle emissions testing in the future, useful data could be obtained. Alternatively if the State could alter the tax reporting procedure for metered pumps, such that the amount of fuel purchased in a city or county could be ascertained, calculations for transportation emissions would be more accurate. The City of Bloomington should call for or support any such efforts in the State in so far as it is able.

(4) Foster Relationships with Energy Providers

The largest contributor to Bloomington's greenhouse gas emissions is building energy usage in electricity and natural gas. Due to changes in accounting procedures at one provider and difficulty in obtaining any information from another, data in these categories is currently limited and may be more so in the future. This information will be necessary for progress on this greenhouse gas reduction initiative to be measured. It is recommended that the City strive to develop relationships with these providers to encourage the exchange of information.

(5) Continue to Support Information-Gathering

Creating an information-rich environment within the city will allow greenhouse gas emissions reduction efforts as well as future initiatives by the city to be more successful. Continued support for reports such as the Bloomington Environmental Quality Indicator Report (BEQI) and indicator reports being developed by other commissions is encouraged. The information obtained from past BEQI reports was crucial in developing this emissions inventory as a first step for the City in implementing the US Mayors Agreement on Climate Change.

(6) Support State and National Emission Reduction Efforts

Finally, support for action to address climate change on both the state and national levels is needed. While the US Mayors Climate Protection Agreement is demonstrating how local initiatives can make real progress on the challenge of climate change[1], this report points out several limitations faced when accounting for greenhouse gases on the local level. A national system of greenhouse gas accounting for both emissions and reductions would help to increase the convenience and accuracy of emissions inventories and promote the widespread adoption of greenhouse gas reduction initiatives.

Conclusion

The inventory reported in this document identifies the major sources of greenhouse gases in Bloomington and quantifies their relative emissions. Taken with the companion document "A Framework for Developing a Greenhouse Gas reduction Plan for Bloomington, Indiana" by Eric Roberts, the strategies that work best for Bloomington can be applied to make a significant reduction in Bloomington's contribution to climate change.

Notes

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